1022300

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 208 734 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.05.2002 Bulletin 2002/22

(51) Int Cl.[7]: A01D 41/12

(21) Application number: 01204363.4

(22) Date of filing: 15.11.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 17.11.2000 US 716069

(71) Applicant: NEW HOLLAND BELGIUM N.V.
B-8210 Zedelgem (BE)

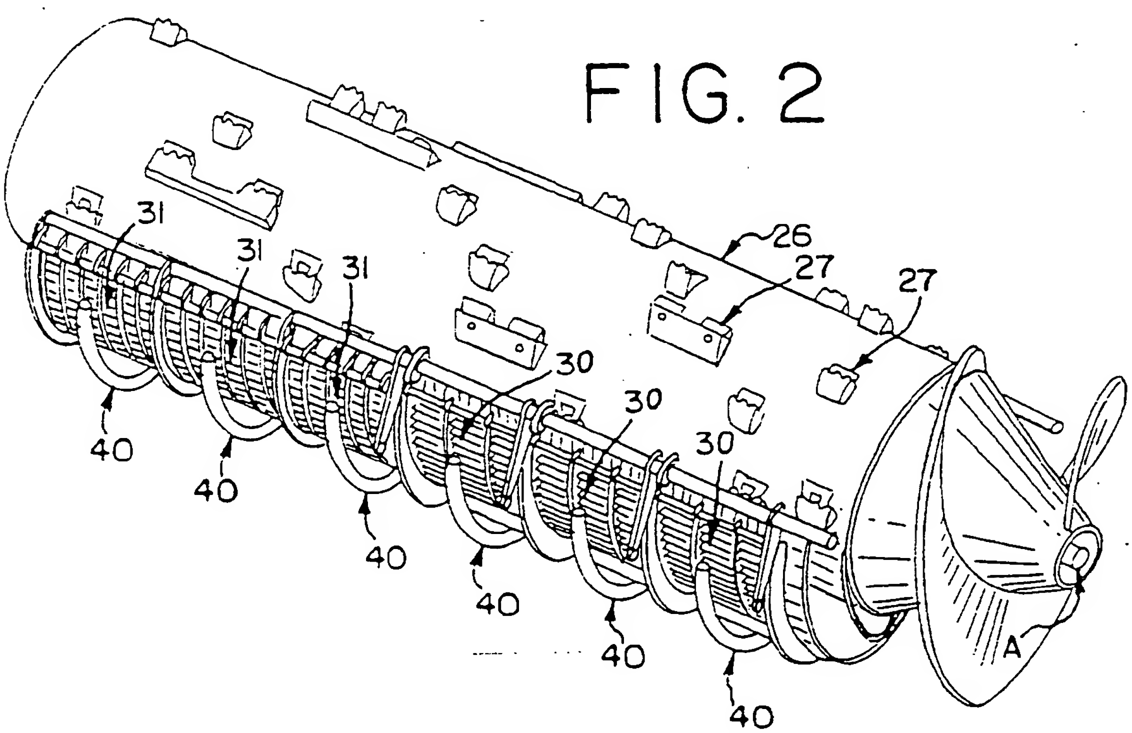
(72) Inventor: Pope, Glenn E.
Viola, IL 61486 (US)

(74) Representative: Vandenbroucke, Alberic et al
New Holland Belgium NV.
Patent Department
Leon Claeysstraat, 3A
8210 Zedelgem (BE)

(54) Sensing system for an agricultural combine

(57) A sensing system for an agricultural combine (10) that measures crop material flow between the threshing system (22) and the sieves (32). A number of sampling positions are provided along the longitudinal axis of the threshing system (22). A sensing member (40) with a vibration sensor (42) is provided at each sampling position to measure the volume of material flow between the threshing system (22) and the sieves (32). In a rotary threshing system the sensing members are hollow tubes (40) that are curved to wrap around a portion of the outside of the concave (30) or the grate (31).

FIG. 2



Description

[0001] The present invention relates generally to agricultural harvesting machines. It relates particularly to means for sensing the flow of crop material between two separation systems, such as the rotary threshing assembly and the cleaning system in a combine harvester.

[0002] An agricultural combine is a common and well-known machine for harvesting crop materials. Agricultural combines are available in various designs and models to perform the basic functions of reaping crop materials from a crop field, separating the grain from the non-grain crop materials, and discarding the non-grain crop materials back onto the crop field.

[0003] A typical combine includes a crop harvesting apparatus, or header, which reaps ripened crop plants from the crop field. The header then feeds the crop materials rearwardly to a threshing apparatus. One type of threshing apparatus that is well-known to those skilled in the art is a rotary thresher. In such a system, the crop materials are introduced to the front end of a rotor assembly, which is oriented longitudinally within the combine body with the rear end positioned angularly upwards from the front end. The crop materials are then threshed in the annular space between a rotating rotor and the inside of a rotor housing.

[0004] Along the exterior of the rotor is a series of rasp bars which repeatedly, but in a controlled manner, strike the crop plants as they spiral through the annular space between the rotor and rotor housing. The rasp bars also co-operate with spiral vanes along the interior of the rotor housing so that the crop plants feed rearward through the rotor assembly.

[0005] As the crop materials feed through the rotor assembly, the fine materials are separated from the course materials. Typically, the fine materials include grain, partial grain heads, and broken pieces of crop stalks; while the course materials include crop stalks, leaves, and empty grain heads. The unwanted course materials continue their rearward travel through the rotor assembly and are discharged out from the rotor assembly's rear end. On the other hand, the fine materials pass through openings in the concave and grate which are positioned along the bottom side of the rotor housing. These materials are then further separated in an area below the rotor assembly by a series of moving sieves in conjunction with a forced air flow. After final separation, the grain is directed to an onboard grain bin through an augering system, with the unwanted fine materials, sometimes referred to as chaff, being discharged out the rear end of the sieves.

[0006] The effectiveness of the threshing system can have a significant impact on the success of a farm's harvesting operations. For example, the efficiency of the threshing system directly affects the time required to complete the harvest. Typically, farmers prefer the harvesting operations to proceed as quickly as possible. One reason that a quick harvest is desirable is the unpredictability of the weather and the risk of losing a portion of the crop due to rain, snow, wind, or hail. Another reason for this urgency is the high cost of the harvesting operation, which includes the cost of combines, trucks, and labour. By operating quickly and efficiently, a farmer can lower the cost of the harvesting operation by harvesting a larger area of land with the same equipment and manpower. Therefore, threshing systems which separate grain and non-grain materials more quickly are desirable.

[0007] In addition, grain losses have an adverse impact on the financial profits of the harvesting operations. Grain losses occur when the threshing system fails to separate some of the grain from the non-grain materials. This unseparated grain is then discharged from the threshing system along with the non-grain materials and is spread back onto the crop field where it is left unrecovered. Farmers are particularly concerned with grain losses because the grain yield from the harvest disproportionately affects the farmer's profits. Typically, the harvest represents the farmer's sole source of revenue, which necessarily must be sufficient to cover all the costs that the farmer has expended to raise the crop. Crop losses, thus, directly reduce the farmer's profits by reducing the amount of recovered grain that can be sold. Therefore, threshing systems which minimise the amount of lost grain are desirable.

[0008] Grain damage also directly reduces the farmer's financial revenues from the harvesting operations. Grain damage occurs when the mechanical threshing system repeatedly strikes the grain with a sufficient impact to crack the grain into fragments. Typically, the amount of damaged grain increases as the grain is threshed longer in the rotor assembly. Thus, greater amounts of grain damage are usually experienced near the rear end of the rotor than at the front end. Damaged grain is less valuable to grain consumers, however. As a result, the farmer receives a lower price if the grain includes an unacceptably high level of fragmented grain. Therefore, a threshing system which minimises grain damage by quickly separating the grain near the front end of the rotor is desirable.

[0009] Manufacturers of combines commonly provide a number of different adjustments that can be made to the threshing system in order to achieve an optimal balance of efficiency, grain loss, and grain damage. For example in one adjustment, the position of the concave can be changed to modify the shape of the annular threshing space between the rotor and the concave. This adjustment is used to balance the flow of fine materials through the concave and grate, which then fall onto the sieves. Experience has shown that the sieves operate most efficiently when a shallow mat of crop material is spread across the top of the sieves. Optimally, this mat will be thick enough to prevent the cleaning fan air from escaping through the sieves but will be thin enough to allow the grain to sink down through the mat. Additionally, the optimal mat will spread evenly across

the width of the sieves but will be somewhat thicker towards the front of the sieves and thinner towards the rear of the sieves. Typically, the concave can be repositioned both in a vertical direction and a side-to-side direction in order to achieve a desired material flow from the rotor assembly to the sieves. Thus, by adjusting the concave inward towards the rotor's axis, a greater amount of fine materials will drop to the sieves along the front end. On the other hand, by adjusting the concave outward and away from the rotor, the material flow to the sieves will move rearward along the axis of the rotor. In a like fashion the concave can be adjusted side-to-side to balance the material flow laterally along the width of the sieves.

[0010] The sieves are also adjustable by either pivoting them towards a closed position or pivoting them towards an open position. Generally, the sieves are adjusted based on the amount of crop material that falls from the concaves. Thus, when a large amount of material falls to the sieves, the sieves will be opened in a wide position to accommodate the extra material. On the other hand, the sieves will be closed in a narrower position when smaller amounts of materials fall to the sieves.

[0011] Similarly, the speed of the cleaning fan can be adjusted to accommodate the volume of material flow from the rotor assembly. In this case, more airflow is needed when large amounts of material are present on the sieves. When smaller amounts of material are present, the fan speed is decreased for less air flow.

[0012] In another adjustment, the angle of the spiral vanes on the inside or the rotor housing can be changed. The angle of the spiral vanes determines the rate at which the crop materials travel rearward through the annular threshing space. Similar to the theory of a screw thread, a high spiral angle causes the crop materials to feed more quickly through the rotor assembly; whereas a low spiral angle slows the feed rate through the rotor assembly. This adjustment, therefore, causes the material flow to the sieves to be moved forward or rearward along the axis of the rotor.

[0013] In a final set of adjustments, the rotational speed of the rotor and the travel speed of the combine can be changed in order to increase or decrease the material flow through the concave and the grate to the sieves. Thus, increasing the speed of the rotor directly increases material flow to the sieves, and decreasing the speed of the rotor correspondingly decreases material flow to the sieves. Likewise, changes to the speed of the combine cause similar increases and decreases of material flow to the sieves.

[0014] While a number of threshing adjustments are available, the combine operator usually has only a limited amount of information available as he attempts to choose an optimal combination of the adjustment settings. Traditionally, the operator has relied primarily on simple visual clues in determining what combine adjustments to make. One such clue that the operator can use is an inspection of the harvested grain in the combine's onboard storage bin. For example, if the grain sample includes an excess of either damaged grain or non-grain materials, the operator will make adjustments accordingly. The operator can also inspect the ground surface of the harvested crop field for discharged grain to determine how much grain has been lost. Additionally, the operator commonly changes the spread of the combine as he travels through the field based on a visual determination of crop conditions.

[0015] These techniques of gathering information, however, are imprecise and are poorly suited for making ongoing adjustments during combining operations. As a result, combine operators typically settle on a balance of adjustments that are believed to be sufficient for a wide range of threshing situations. Operators also avoid making adjustments in the middle of combining operations and instead prefer to choose a single set of adjustments which remain unchanged during the harvesting operations.

[0016] Some manufacturers have attempted to provide combine operators with additional information on the performance of the threshing system to enable more accurate selection of threshing adjustments. One such system is a grain loss sensor that informs the operator how much grain is being discharged from the rear end of the rotor assembly. Typically, these sensors include a sensing member along a rear end of the rotor assembly that registers the number of grain seed impacts against the sensing member. The operator can then estimate the amount of grain that is being lost from the rotor's discharge end. These sensors, however, are of minimal usefulness because the information that is provided, is limited in scope.

[0017] Hence, it is an object of the invention to improve the operation of a harvesting machine, by making adjustments based on a more useful type of data.

[0018] According to one aspect of the present invention there is provided an agricultural harvesting machine comprising:

> a first separation system that separates course crop materials from grain and fine non-grain materials;
> a second separating system that separates said grain from said fine non-grain materials; and
> a sensing system located between said first separation system and said second separation system for sensing at least a portion of the crop flow between said first and second separation systems,

characterised in that sensing system comprises a plurality of flow sensing members located at a plurality of spaced sensing positions.

[0019] Such sensing system provides a more useful type of data, i.e. more detailed information about the flow of materials between the rotor assembly and the sieves. Preferably, these data would provide information on the dispersal pattern of the grain which passes

through the concave and the grate. Sensing members may be provided at more than two, preferably at least six spaced locations. Based on the data provided by the sensing members, an optimal set of adjustments could then be chosen for the threshing system in order to maximise the effectiveness of the sieves.

[0020] In a preferred embodiment the measurements of crop material flow are used to automatically change the threshing system adjustments.

[0021] The sensing members may be provided along the longitudinal axis of the first separation separation system, e.g. the rotor of a rotary thresher.

[0022] According to another aspect of the invention, a sensing member is provided which comprises a body member constituted by a hollow tube that is shaped in a curved form that wraps along the outside of the concave or grate. Crop flow may be monitored by an appropriate sensor, such as a vibration sensor, installed within the hollow body member. Such vibration sensor may measure vibrations in the hollow tube that occur when crop materials strike the tube. Thus, the sensing members can measure the crop flow which passes through the concave and the grate from the rotor assembly to the sieves.

[0023] Advantageously, a pair of sensing members may be provided at one sensing position. Such sensors may extend from a middle along opposite sides of the separation system. This enables measurement of the proportion of the crop material that flows from opposite sides of the threshing assembly.

[0024] The data from the sensing members is used to control a number of adjustments to the threshing system in order to achieve optimal separation performance. One embodiment provides a user-readable output of the measurement of crop material flow, which an operator can use to manually change the threshing system's adjustments. Another embodiment provides a control system that automatically changes the threshing system's adjustments based on the measurement of crop material flow.

[0025] Hence, according to a further aspect of the present invention there is provided a method for controlling settings of an agricultural harvesting machine, said machine comprising:

a first separation system that separates course crop materials from grain and fine non-grain materials;
a second separating system that separates said grain from said fine non-grain materials; and
a sensing system located between said first separation system and said second separation system for sensing at least a portion of the crop flow at a plurality of sampling positions between said first and second separation systems,

said method comprising the steps of:

- measuring the flow of crop material at said plurality of sampling positions; and
- changing a separation adjustment based on said measurements of crop material flow.

[0026] An embodiment of the present invention, including its construction and method of operation, will now be described in further detail, by way of example, with reference to the following drawings, in which:

Figure 1 is a side elevational view of an agricultural combine, showing part of the combine body broken away to illustrate the rotor assembly and sieves;
Figure 2 is a perspective view of a rotor, showing a concave and grate positioned below the rotor with sensing members positioned below the concave and the grate;
Figure 3 is a front sectional view of Figure 2; and
Figure 4 is an enlarged view of a sensing member; showing part of the tube surface broken away to illustrate the vibration sensor.

[0027] Referring now to the drawings, and particularly to Figure 1, there is shown a self-propelled agricultural combine 10. The combine 10 includes a body 12 supported by wheels 14 and an engine (not shown) for driving the wheels 14 to allow the combine 10 to move from place to place. An operator's station 16 is positioned towards the forward end of the combine body 12 and includes numerous controls to allow the operator to adjust the functions of the combine 10. At the forward end of the combine 10 is a crop harvesting header 18 that severs and gathers the ripened crop materials from the crop field. After cutting the stems of the crop materials or collecting the crop materials from a prepared windrow, the crop materials are fed rearward through a feeder housing 20 to the threshing assembly 22.

[0028] Although a variety of threshing systems are known to those skilled in the art, the preferred embodiment of the invention includes a rotary threshing assembly 22. In such a system, the crop materials are fed into the forward end of the assembly 22. An impeller 24 is attached to the forward end of the rotor 26 to assist entrance of the crop materials. Spiral vanes 29 attached to the top side of the interior of a rotor housing 28 induce rearward movement of the crop materials through an annular space between the stationary rotor housing 28 and the rotating rotor 26. As the crop materials travel rearward, they are threshed by a series of rasp bars 27 or other threshing elements attached to the exterior of the rotor 26.

[0029] Along the bottom side of the rotor housing 28 is a concave 30 and a grate 31 which have perforated openings that allow grain and other fine materials to pass through and away from the rotor assembly 22. Larger materials, such as crop stalks, continue rearward through the rotor assembly 22 and are discharged out the rear end of the rotor assembly 22.

[0030] After falling through the concave 30 or the

grate 31, the grain and other fine materials land on top of a series of sieves 32 located below the rotor assembly 22. A driving mechanism (not indicated) creates a constant, reciprocating motion between the sieves 32 so that as the crop materials pass through the sieves. A number of louvers (not shown) attached to the sieves 32 further separate the grain from the unwanted chaff and other fine materials. After passing through the sieves 32, the grain falls to the bottom of the combine body 12 and is augered up to an onboard storage bin 13. A cleaning fan 38 located forward of the sieves 32 blows forced air across the sieves 32, which helps to separate the grain from the fine materials. The cleaning fan 38 also discharges the unwanted fine materials out the rear end of the sieves 32.

[0031] Experience has shown that the sieves 32 operate most efficiently when a shallow mat of crop materials is spread on top of the sieves 32. Optimally, the thickness of this mat will be even across the width of the sieves 32 and will be somewhat thicker near the front of the sieves 32 than towards the rear of the sieves 32. A number of threshing system adjustments are available, which are well-known in the art, for modifying the thickness and the placement of this mat of crop materials. Thus, by selecting appropriate settings for each of these adjustments, a combine operator can improve combine 10 efficiency by ensuring that an optimal mat of crop materials is provided on the sieves 32.

[0032] In one threshing system adjustment, the relative position of the concave 30 to the rotor 26 can be changed. The concave 30 is located forward of the non-adjustable grate 31 and may be moved inward or outward from the rotor's axis or may be moved side-to-side. In another adjustment, the louvers of the sieves 32 may be pivoted between opened or closed positions. The cleaning fan 38 speed may also be increased or decreased. In still another adjustment, the angle of the spiral vanes 29 can be changed. Finally, the rotational speed of the rotor 26 or the travel speed of the combine 10 can be changed.

[0033] Turning now to Figures 2 through 4, a plurality of sensing members 40 are included below the concave 30 and the grate 31. Although a variety of sampling positions are possible, the preferred embodiment includes six sensing members 40 equally spaced along the length of the rotor assembly 22.

[0034] Preferably, the sensing members 40 are hollow tubes made from stainless steel. Attached to the inside of each tube 40 is a vibration sensor 42 that can detect vibrations in the sensing tube 40. Preferably, the vibration sensor 42 is a piezoelectric sensor 42.

[0035] When crop materials strike the sensing member 40 as the materials travel between the rotor assembly 22 and the sieves 32, the vibration sensor 42 counts the number of strikes in order to determine the volume of material flow. In addition, the vibration sensor 42 distinguishes between strikes of grain seeds, grainseed fragments, and non-grain materials because the vibrational magnitudes caused by these materials differ according to their different hardnesses.

[0036] As will be seen from the figures and understood by those skilled in the art, the sensing member 40 does not provide data from the entire flow of material which travels between the rotor assembly 22 and the sieves 32. Instead, a narrow sensing member 40 measures only a sample of the material flow. The entire material flow is then estimated from the sample measurements provided by the sensing member 40. A sampling technique such as this, which uses a narrow sensing member 40, avoids excessive obstruction of the crop flow. Thus, the majority of the crop flow travels freely and unobstructed through the concave 30 and the grate 31 to the sieves 32.

[0037] Preferably, the sensing members 40 are attached to the concave 30 and the grate 31 with rubber mounts 44. The rubber mounts 44 isolate the sensing tube 40 from the rest of the combine 10 to ensure that other equipment vibrations do not interfere with the measurements of the sensing members. This allows the vibration sensors 42 to more accurately measure the vibration caused by crop material strikes.

[0038] The sensing members 40 can be configured in a number of different forms to achieve accurate measurements of the material flow. In one form, the sensing member 40 is configured in a semi-circular arc that wraps around the width of the concave 30 or the grate 31. This form allows accurate measurements of the material flow around the entire width of the concave 30 or the grate 31. In another form, two sensing members 40 are provided at each longitudinal sampling position. In this form, the first sensing member 40A extends from the bottom of the concave 30 or the grate 31 along one side of the width of the concave 30 or the grate 31. The second sensing member 40B is then isolated from the first sensing member 40A with rubber mounts 44 and extends from the bottom along the other side of the width. Thus, in this latter embodiment of the invention, accurate material flow measurements are possible independently for each side of the rotor assembly 22 since each of the two sensing members 40A, 40B includes a separate vibration sensor 42.

[0039] The sensing system, therefore, provides a number of separate sample measurements of the material flow through the concave 30 and the grate 31. This data can provide an accurate representation of variations in the material flow along the length of the rotor assembly 22 and from each side of the rotor assembly 22. This information can then be used to modify the material flow or the performance of the sieves in order to achieve more efficient grain separation.

[0040] One embodiment of the invention provides a user-readable output display (not shown) of the sensor data in the operator's station 16. The operator can then manually change the threshing system adjustments. Preferably, the output display allows the operator to vary the adjustments as the combine 10 is harvesting the

crop field.

[0041] In another embodiment shown in Figure 5, a control system is included that can automatically change the threshing system adjustments. The control system includes an algorithm 46 that analyses the data from the sensing members 40 and determines the appropriate changes to the threshing system adjustments. The algorithm 46 can then individually change each of the threshing system adjustments, such as moving the concaves inward or outward 48, moving the concaves side-to-side 50, opening or closing the sieves 52, increasing or decreasing the cleaning fan speed 54, modifying the helix angle of the spiral vanes 56, increasing or decreasing the rotor speed 58, and increasing or decreasing the combine speed 60. The preferred control system, however, simultaneously changes each of the adjustments to achieve an optimal mat of crop materials on the sieves 32. Thus, in the preferred control system, concave position 30, 48, 50; sieve opening 32, 52; cleaning fan speed 38, 54; spiral vane angle 29, 56; rotor speed 26, 58; and combine speed 10, 60 are all controlled by the control system.

[0042] While a preferred embodiment of the invention has been described, it should be understood that the invention is not so limited, and modifications may be made without departing from the invention. The scope of the invention is defined by the appended claims, and all devices that come within the meaning of the claims, either literally or by equivalence, are intended to be embraced therein.

Claims

1. An agricultural harvesting machine (10) comprising:

    a first separation system (22) that separates course crop materials from grain and fine non-grain materials;
    a second separating system (32, 38) that separates said grain from said fine non-grain materials; and
    a sensing system located between said first separation system (22) and said second separation system (32, 38) for sensing at least a portion of the crop flow between said first and second separation systems,

    characterised in that sensing system comprises a plurality of flow sensing members (40) located at a plurality of spaced sensing positions.

2. An agricultural harvesting machine according to claim 1. **characterised in that** said flow sensing members (40) are located at spaced sensing positions along the longitudinal axis of said first separation system (22).

3. An agricultural harvesting machine according to claim 1 or 2, **characterised in that** said plurality of sensing members includes more than two sensing members (40).

4. An agricultural harvesting machine according to any of the preceding claims, **characterised in that** said plurality of sensing members includes at least six sensing members (40).

5. An agricultural harvesting machine according to any of the preceding claims. **characterised in that** at least one of said sensing members (40) has a body member constituted by a hollow tube.

6. An agricultural harvesting machine according to any of the preceding claims. **characterised in that** at least one of said sensing members (40) has a body member made out of stainless steel.

7. An agricultural harvesting machine according to any of the preceding claims, **characterised in that in that** at least one said sensing members (40) comprises a body member and a vibration sensor (42) attached to said body member.

8. An agricultural harvesting machine according to claim 7, **characterised in that** said vibration sensor is a piezoelectric sensor (42).

9. An agricultural harvesting machine according to any of the preceding claims. **characterised in that** at least one of said sensing members (40) is isolated with a dampening material (44).

10. An agricultural harvesting machine according to any of the preceding claims, **characterised in that** at least one of said sensing members (40) has a curved form that wraps around a portion of said first separation system (22).

11. An agricultural harvesting machine according to any of the preceding claims, **characterised in that**, at at least one sensing position, there is provided more than one sensing member (40A, 40B).

12. An agricultural harvesting machine according to claim 11, **characterised in that** said more than one sensing member includes two sensing members (40A, 40B) extending from a middle of said first separation system (22) along opposite sides of said first separation system.

13. An agricultural harvesting machine according to any of the preceding claims, **characterised in that**:

    said first separation system (22) comprises a rotor (26) mounted for rotation about a fore-

and-aft extending axis and a concave (30) and/ or grate (31) provided below said rotor; and said second separation system comprises at least one sieve (32) provided below said first separation system (22).

14. An agricultural harvesting machine according to any of the preceding claims, **characterised in** it further comprises a user-readable output display linked to said sensing system for displaying flow data to an operator of said machine.

15. An agricultural harvesting machine according to any of the preceding claims, **characterised in that** it further comprises a control system linked to said sensing system, said control system including an algorithm (46) for analysing flow data from said sensing system and determining appropriate changes to a setting of said harvesting machine (10).

16. An agricultural harvesting machine according to claim 15, **characterised in that** said control system further includes means for automatically applying said determined changes to said setting of said harvesting machine (10).

17. A method for controlling settings of an agricultural harvesting machine (10), said machine comprising:

 a first separation system (22) that separates course crop materials from grain and fine non-grain materials;
 a second separating system (32, 38) that separates said grain from said fine non-grain materials; and
 a sensing system located between said first separation system (22) and said second separation system (32, 38) for sensing at least a port-ion of the crop flow at a plurality of sampling positions between said first and second separation systems,

 said method comprising the steps of:

 - measuring the flow of crop material at said plurality of sampling positions; and
 - changing a separation adjustment based on said measurements of crop material flow.

18. A method according to claim 17, **characterised in that** said plurality of sampling positions includes more than two positions spaced along a longitudinal axis of said first separation system (22).

19. A method according to claim 18. **characterised in that** said plurality of sampling positions includes at least six positions spaced along a longitudinal axis of said first separation system (22).

20. A method according to any of the claims 17 to 19, **characterised in that** said measuring step comprises measuring the proportion of said crop material that flows from opposite sides of said first separation system (22).

21. A method according to any of the claims 17 to 20, **characterised in that**:

 said method further comprises:

 - displaying flow data derived from said flow measurement to an operator; and

 said adjustment changing step comprises manually changing said separation adjustment by said operator based on said flow data display.

22. A method according to any of the claims 17 to 20, **characterised in that** said adjustment changing step comprises automatically changing said separation adjustment with a control system using an algorithm (46) based on said flow measurement.

23. A method according to any of the claims 17 to 22, **characterised in that** said adjustment changing step comprises moving a concave (30) or grate (31) inward or outward from a rotor (26).

24. A method according to any of the claims 17 to 23, **characterised in that** said adjustment changing step comprises moving a concave (30) or grate (31) side-to-side relative to a rotor (26).

25. A method according to any of the claims 17 to 24, **characterised in that** said adjustment changing step comprises opening or closing a sieve (32).

26. A method according to any of the claims 17 to 25, **characterised in that** said adjustment changing step comprises increasing or decreasing the speed of a cleaning fan (38).

27. A method according to any of the claims 17 to 26, **characterised in that** said adjustment changing step comprises modifying the helix angle of a spiral vane (29).

28. A method according to any of the claims 17 to 27, **characterised in that** said adjustment changing step comprises increasing or decreasing the speed of a rotor (26).

29. A method according to any of the claims 17 to 28, **characterised in that** said adjustment changing step comprises increasing or decreasing the travel

speed of said harvesting machine (10).

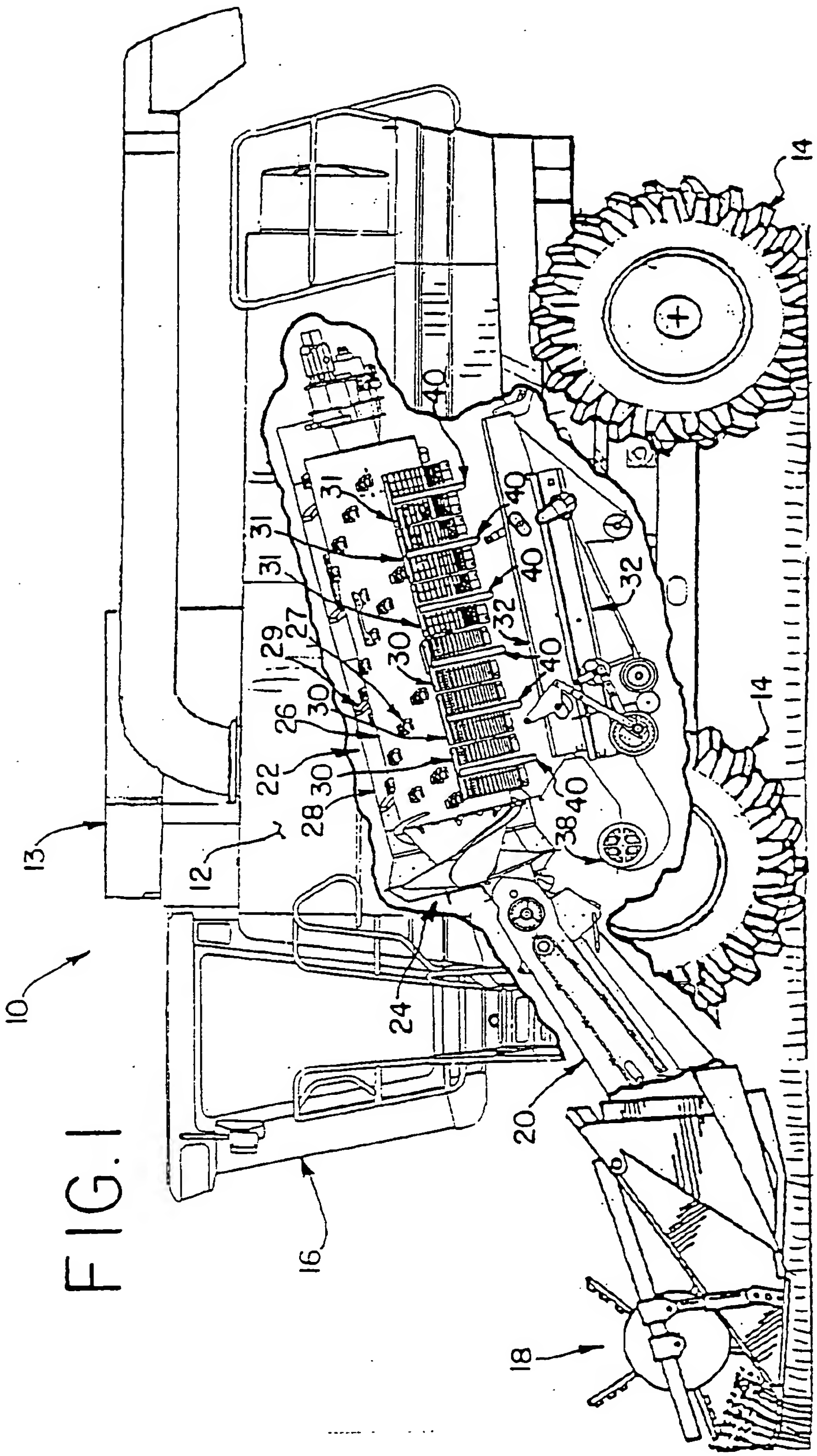


FIG. 1

FIG. 2

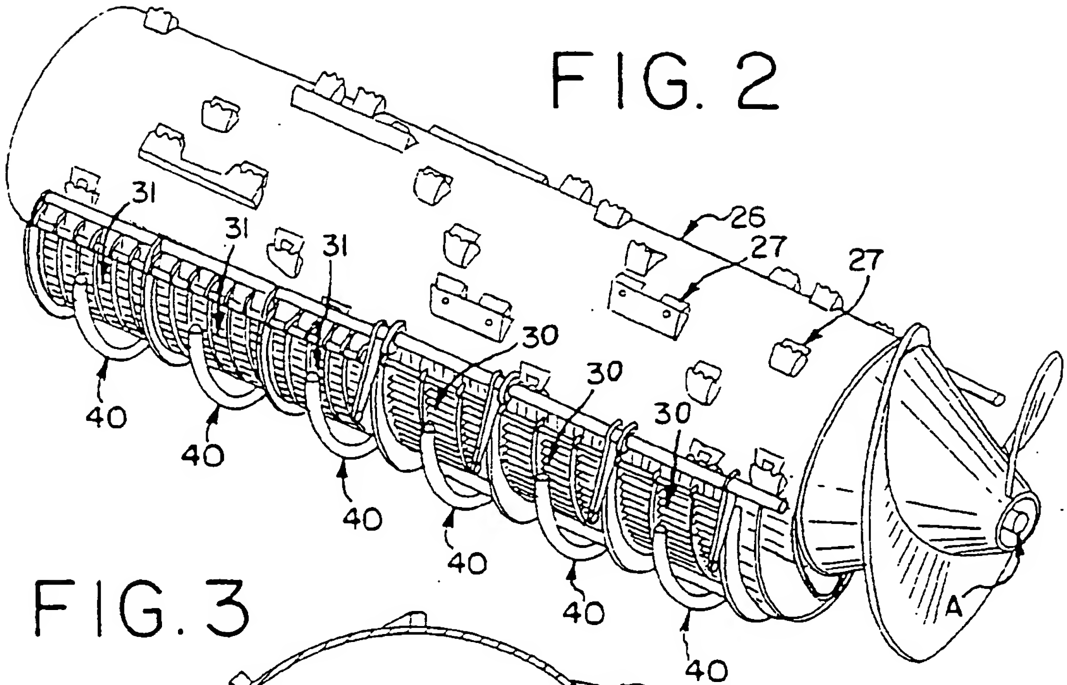


FIG. 3

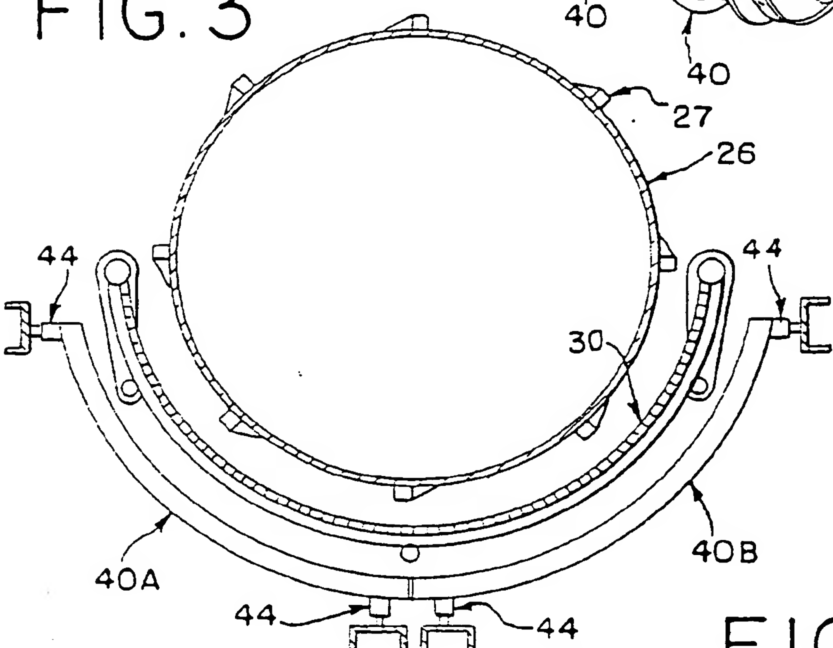
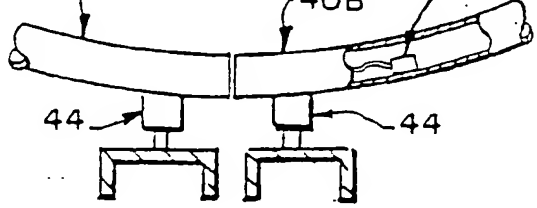


FIG. 4



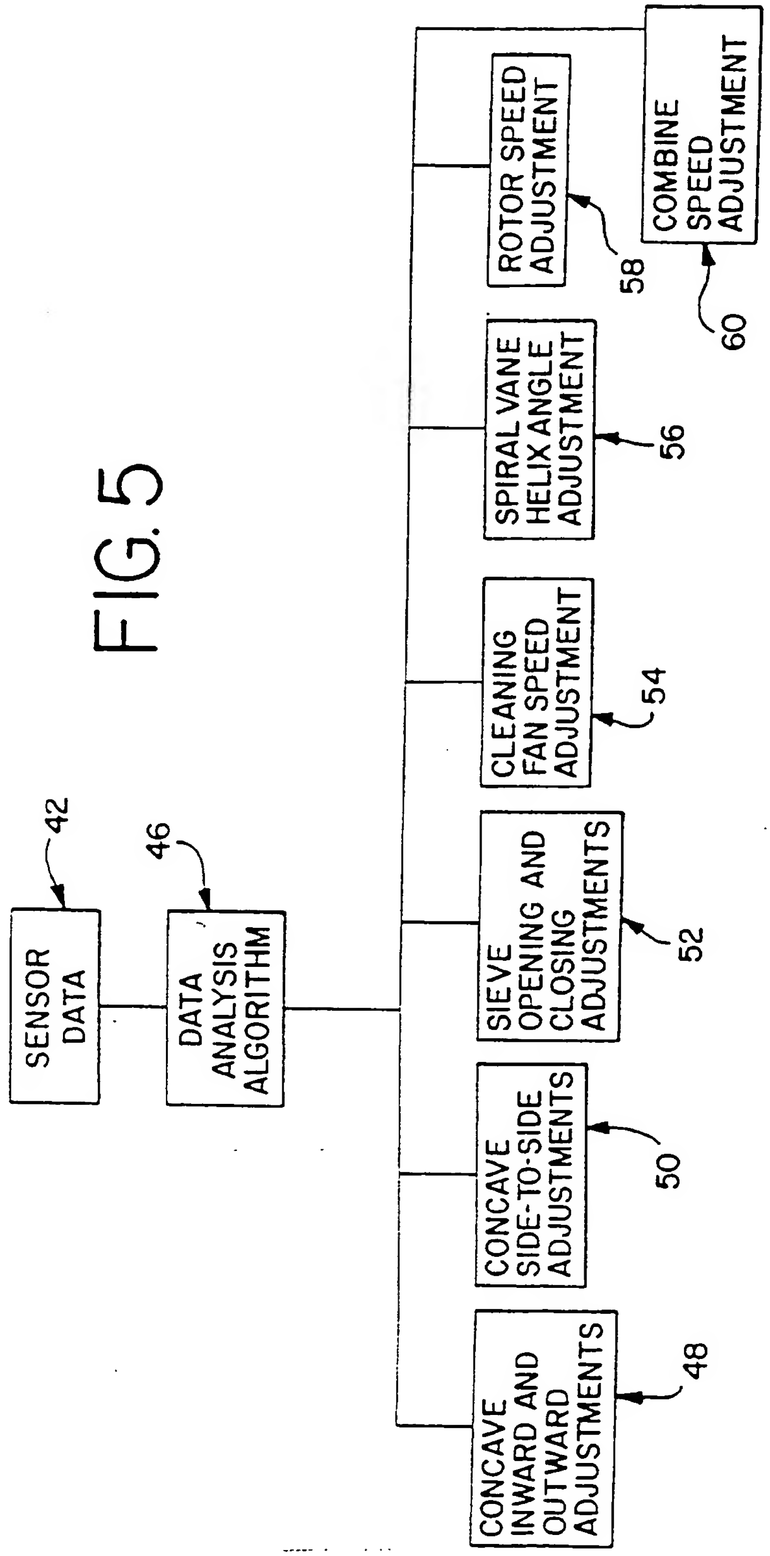

SENSOR DATA
42
DATA ANALYSIS ALGORITHM
46
CONCAVE INWARD AND OUTWARD ADJUSTMENTS
48
CONCAVE SIDE-TO-SIDE ADJUSTMENTS
50
SIEVE OPENING AND CLOSING ADJUSTMENTS
52
CLEANING FAN SPEED ADJUSTMENT
54
SPIRAL VANE HELIX ANGLE ADJUSTMENT
56
ROTOR SPEED ADJUSTMENT
58
COMBINE SPEED ADJUSTMENT
60

FIG. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 20 4363

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X A	DE 40 35 471 A (SAECHSISCHE MAEHDRESCHERWERKE) 29 May 1991 (1991-05-29) * the whole document *	1-4,7-9, 11, 17-20, 23,28,29 14-16, 21,22	A01D41/12
P,A	GB 2 356 546 A (FORD NEW HOLLAND NV) 30 May 2001 (2001-05-30) * page 25, last paragraph - page 26, paragraph 1 *	13	
A	US 4 259 829 A (STRUBBE GILBERT J I) 7 April 1981 (1981-04-07) * figures 3,8 *	26	
A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 310 (C-0736), 4 July 1990 (1990-07-04) & JP 02 107122 A (KUBOTA LTD), 19 April 1990 (1990-04-19) * abstract *		TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	DE 43 20 977 A (MAEHDRESCHERWERKE AG) 5 January 1995 (1995-01-05)		A01D
A	DE 12 65 476 B (WIENECKE)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 February 2002	De Lameillieure, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 20 4363

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-02-2002

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
DE 4035471	A	29-05-1991	DD	289685	A5	08-05-1991
			DE	4035471	A1	29-05-1991
GB 2356546	A	30-05-2001	WO	0137632	A1	31-05-2001
			WO	0137636	A1	31-05-2001
			WO	0137637	A1	31-05-2001
			WO	0137638	A1	31-05-2001
			WO	0137639	A1	31-05-2001
			EP	1162872	A1	19-12-2001
			EP	1148776	A1	31-10-2001
			EP	1162873	A1	19-12-2001
			EP	1154682	A1	21-11-2001
			EP	1150558	A1	07-11-2001
US 4259829	A	07-04-1981	NONE			
JP 02107122	A	19-04-1990	JP	1970930	C	27-09-1995
			JP	6101965	B	14-12-1994
DE 4320977	A	05-01-1995	DE	4320977	A1	05-01-1995
DE 1265476	B		NONE			

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82